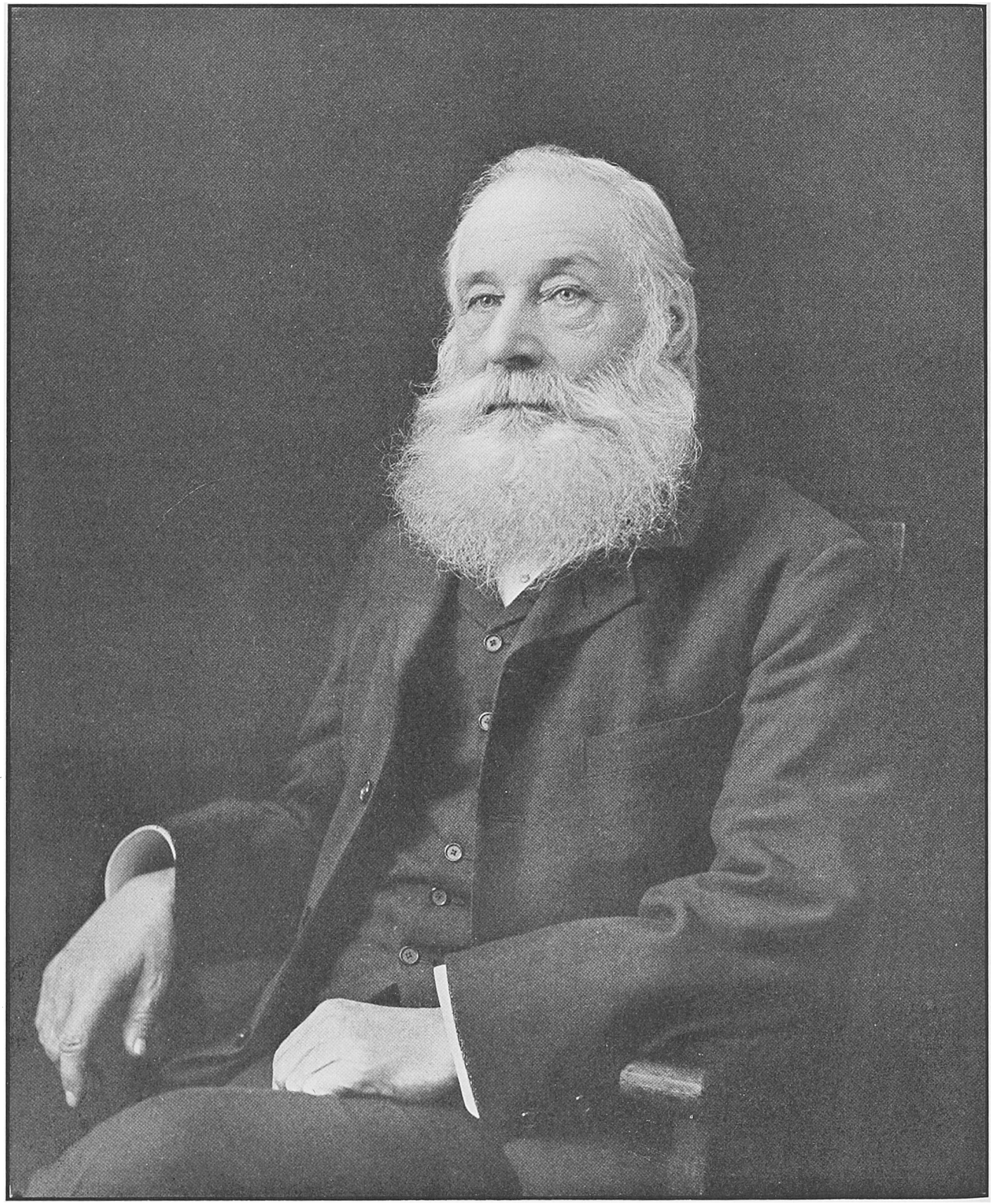

SIR WILLIAM HENRY PERKIN

(*See opposite page*)

PERKIN'S DISCOVERY OF ANILINE DYES

By Professor Charles E. Pellew

(*See opposite page*)

A GREAT chemist was once describing, to a mixed audience, an important investigation that he had been engaged in, when one of his hearers suddenly asked him—"What good is all this work of yours? What possible value has it or do you expect it to have, to pay for all the trouble you have taken with it?" Quick as a flash the lecturer answered—"What do *you* consider the value of a baby?"

Perhaps the most extraordinary case on record, of a simple scientific discovery leading directly, in but a few years, to results of vast importance to the whole human race, is the discovery in 1856 of the first aniline color by a clever English boy. In fact the discovery of aniline colors and the foundation of the coal-tar dyestuff industry by Sir William Henry Perkin has proved to be one of the most important events in the history of civilization; and the world, or at least the whole scientific world, had come to appreciate it before the death of the discoverer.

WILLIAM HENRY PERKIN

Perkin himself was the son of a carpenter and builder in London, and when only twelve years old his attention was directed towards chemistry as a life work by some chemical experiments a young friend showed him. He then entered the City of London School, where he had the opportunity, an extremely rare one in England at that time, of listening to lectures upon chemistry and physics by a well-educated and interesting master who had been a student of the famous German chemist Hofmann. A few years before this, Hofmann had been brought over from Liebig's laboratory at Giessen, largely by the influence of Prince Albert, to be the head of the recently started Royal College of Chemistry. He was a man of great ability and, what was more important, he had the power of imparting his zeal and enthusiasm to his students. So it was only natural that after a couple of years at school, where he was soon made lecture assistant to his master, the boy Perkin, somewhat against the wishes of his father, who would have preferred to make an architect of him, decided, himself, to enter the Royal College and definitely adopt chemistry as his life work.

When sixteen years old we find him as one of Hofmann's pupils, and after rapidly completing the regular courses he was set by his chief at research work. Hofmann had made his reputation as a chemist by his work in organic chemistry, a subject very little understood at that time, and the boy's first research, an unsuccessful one, was on *anthracene*, a substance found in pitch and tar. Another research on a kindred subject turned out satisfactorily and Hofmann then promoted the lad of seventeen years to be his assistant in the research laboratory. This left him but little time for private work by day; so at night he used to work at his own experiments in a rough little laboratory he had constructed at home. Here, with a friend who was a fellow assistant in the laboratory, he worked out a careful investigation of a new compound which, as he mentioned in his paper on the subject, not only was strongly colored itself, but had the power of staining and coloring other bodies like paper, straw, etc.

HIS DISCOVERY

It so happened that, in a report upon the work of the College some years before, Hofmann had referred to the possibilities of making, artificially, the important and then extremely expensive drug *quinine*, and had suggested a way of attacking this problem—a problem, by the way, which has not yet been solved. During the Easter vacation of 1856 Perkin tried his hand at it by a new method which he thought out for himself. His first attempt proved unsuccessful, so he tried again, using this time as his starting-point the substance known as "aniline."

Aniline (*anil*—an Oriental name for Indigo) is a strong-smelling, oily liquid with very interesting chemical properties, discovered some thirty years before as a product of the distillation of the dyestuff indigo. Several chemists had later found out other ways of preparing it and it was Hofmann who had shown in a very important series of investigations that all these products were the same, and had made a number of new salts and other compounds from it. One chemist, by the way, had noticed years before that this substance turned violet blue when acted on by chloride of lime and had named it *cyanol* (blue oil) in consequence. With much difficulty Perkin obtained some of this material, and tried, quite in accord with the chemical ideas of that period, though to a modern chemist in an utterly crude and almost barbarous manner, to forcibly change it into quinine by warming it with a solution of bichromate of potash, the brilliant orange-colored crystal to be seen so often in druggists' windows. Instead of the clear white crystals that he was looking for, he obtained a brownish, muddy precipitate which, when filtered out and tested, was found to dissolve in weak acid and in alcohol to a violet-colored liquid.

Up to this point Perkin's experience was what might have happened and, probably, had often happened to almost any bright, keen student in a laboratory of organic chemistry. Colored bodies and bodies making colored solutions had been constantly met with by every one who had worked with aniline. Hofmann himself, so it appeared afterwards, had run across them frequently; and considering them, as everybody else did at the time, annoying and worthless side-products, had spent much time and energy in washing them out and throwing them away, so as not to contaminate the nice, clean crystalline salts that he was trying to get.

HOW PERKIN FOLLOWED OUT HIS DISCOVERY

But Perkin here had a touch of genius which raised him forever above the ranks of his contemporaries. As he himself explained it half a century later, he had a close friend, of about his own age, who was working in a silk dye-house not

far off, and this boy had taken Perkin through the little works and frequently talked dyeing problems with him. And then too, his recently completed, though not yet published investigation had shown him the interest and possible value of dyeing tests made with newly discovered colored bodies. So when he found that brown precipitate of his made a bright violet solution, he at once hunted up an old silk handkerchief he had been using round the laboratory to clean up his apparatus; carefully wetting it, he dipped it in the warm liquid. The silk at once took up the dyestuff and turned a brilliant lilac color; and Perkin, immensely interested, dried it, pressed it out and started for home with it, to show it to his people. On the way he stopped at the dye-house and showed it to his friend who, greatly impressed, called the head dyer to look at it. By good chance this man happened to be both intelligent and good-natured. He evinced great interest in the dyed handkerchief, and when he heard that the dyestuff had just been discovered by this boy, he spoke to him seriously about it. He finished by assuring him that, if the color was fairly fast to light, and was not exceedingly expensive to make, the discovery was a very important one, and he strongly urged him to take out a patent for it, and push it to the utmost.

Of course when he reached home that night young Perkin was full of his discovery and its possibilities. All the family shared his enthusiasm. The father, an unusually broad-minded man of his class and times, told him to apply at once for a patent—which he would pay for, and assured him that if it proved promising he would invest all his savings to make its manufacture a success. His elder brother also, who was in business at the time, said that in that case he would give up his position and take charge of the financing and bookkeeping. The question of fastness to light was easily settled, and to his delight the color proved comparatively fast, faster than most of the vegetable colors then in use; indeed considerably faster than most of the aniline colors discovered for many years afterwards. But the question of expense was a serious one. Perkin had used aniline for his experiment which he had himself distilled from indigo at a prohibitive cost. But only a few years before, investigations by Hofmann and others upon aniline had showed that it could be prepared without much difficulty from coal-tar.

COAL-TAR AS A SOURCE OF DYE-STUFFS.

Coal-tar had been the great bugbear of the rapidly growing coal-gas industry for some forty years. It was easy enough to heat soft, rich coal in retorts, and thus develop great volumes of illuminating gas at very low cost. But when this gas was cooled down and passed through mains and gas-pipes into houses, there was deposited from it a heavy, sticky, black, foul-smelling mess, which clogged the pipes and valves and caused endless trouble. Chemists and engineers had invented cooling and scrubbing devices of various sorts by which the gas was thoroughly purified and freed from the coal-tar before leaving the gas works. But this left tar on their hands in large quantities and no one knew what to do with it. Some works tried running it into the rivers, with most disastrous results—the heavy portion settled and formed objectionable mud-banks, and the lighter parts floated as an offensive scum on the water. Then they tried carting it away from the works in tank carts and burying it in pits in some lonely locality. In some cases, where sand dunes or large stretches of waste land could be used, they would dig pits and fill them with it and then light it, making great fires with dense clouds of smoke. Chemists had for years been studying this tar, but as yet had found no important use for it; and now, if only the laboratory experiments could be made successful on a large scale, it would furnish an abundant and very cheap source of aniline for making dyestuffs.

PERKIN STARTS A NEW INDUSTRY

Before long Perkin had satisfied himself and his family that this was a satisfactory solution of the problem. A patent was granted in the summer of 1856. Strongly against the advice of Hofmann, Perkin resigned his position at the Royal College to work out the endless details of using a laboratory experiment commercially. The next summer work was begun on the factory, and by December 1857 the new dye was being supplied to some of the leading dyeing firms in England. The boldness of this undertaking can hardly be appreciated at this time. Neither Perkin nor any of his family had the slightest experience in manufacturing of any sort, and as for the manufacture of fine organic chemicals, at that time it was practically untried, not only in England but all over the world.

Long afterwards, when the whole scientific world was joining hands to shower honors on Perkin on the fiftieth anniversary of his great discovery, the American chemists, not to be outdone, invited him to come across the ocean and receive their congratulations in person.

After the more formal ceremonies had been attended to—public dinners, receptions, honorary degrees, medals and the like—the Chemists' Club took occasion to welcome him at a more informal function, namely a beefsteak dinner at their house. Sir William (he had been knighted that summer) seemed to enjoy himself, and when pressed to speak gave us a rambling, informal little talk about the differences between chemical manufacturing now and in his early days. "Why!" said he "you boys don't know anything about what the difficulties were then! There were no supplies. We had to make and purify our own chemicals and reagents. There was no apparatus, large or small. We had to make it ourselves, or design what we wanted, and try to get it made by some one who couldn't imagine what it was to be used for, and was too stupid to follow directions. But the expense! Why, you young fellows (!) think you are ruined if you pay a few cents a pound for strong nitric acid. It cost us almost as many shillings, and it was very hard to get it, and not right when it did reach us. Concentrated sulphuric acid which you can get with ease and of any strength you want, we could not get at all; and some of our experiments, in consequence. . . . " And so he rambled on.

One of us passed the word down the table and when Sir William paused for breath a voice was heard: "Sir William, how much did you get in those days for that *mauve* dye of yours?" The old gentle-

man pulled himself together, thought for a moment and then, with a little chuckle, said "Well, to say the truth, gentlemen, for the first five years I sold every scrap of that dyestuff I could make for *three guineas and a half an ounce.*" And we all laughed —knowing as we did that, at the time, 1906, much stronger and more brilliant colors of that class were being sold, in open market, at not over forty cents a pound.

For, from the very beginning, the industry proved a success. The public were greatly interested in the brilliant new colors and when, in the course of a few years chemists began putting new ones on the market, the industry soon was recognized as important. Perkin's first dye, *mauve,* was superseded in 1862 by the introduction of a series of very brilliant *violets,* one of which, discovered by Perkin's old teacher, is well known to this day as Hofmann's Violet. But Perkin never ceased to be an investigator, and, while constantly working out improvements in the process, new ways of making the dyes and new methods of using them after they were made, he never lost his interest in making and discovering new compounds, and with the help of a good staff of chemists, kept for his works the start with which they had begun.

Years afterwards an English chemist who, almost from the beginning, had been one of Perkin's associates, told some friends how he had first entered the color industry. He was one of Hoffmann's men, a few years older than Perkin, and one day, as Perkin was going home after a long day's work in the laboratory, he overtook him and slapping him vigorously on the back, greeted him warmly: "Well, Perkin, old man, how are you coming along with that wonderful new purple dye of yours?"

PERILS OF AN INVENTOR

Poor Perkin at the time was trying hard to get his first patent and was doing his work behind tightly closed doors, confiding only in one or two intimate friends beside his family. So he was horrified, and started to disclaim any such discovery. But his friend kept on relentlessly, laughing at his protestations, telling him facts which he supposed were closely hidden, about the shade, its fastness, its power of dyeing animal substances and the like—till Perkin gave in and told him that he *was* working on a new purple dye, and had just run across some difficulties in which, perhaps, his friend might be able to help him.

It was years before his friend told him that his wonderful and inexplicable knowledge of the strictly guarded secret was all a bluff on his part. He had happened that afternoon to run into Perkin leaving the College in a brown study with his head down, evidently pondering on some deep problem; as he came up to him from behind he noticed he was twisting his hands together behind his back, and saw that they, although evidently recently washed, were strongly stained *bright violet!* He proved one of Perkin's very best men.

The greatest advance in the dyestuff industry came in the year 1869, when two German chemists explained the composition of the dyestuff *alizarin,* the valuable constituent of madder, and thus the basis of Turkey-red dyeing, and the fastest and most brilliant red dye known in the world. Directly this paper appeared, Perkin started to work out a practical method of making it from his old acquaintance *anthracene* and before the end of the year his works were supplying the English market with these new and wonderfully fast colors under his own patents. Since that time hundreds, indeed, thousands of new dyestuffs have been discovered, tested and either rejected as of inferior quality, whether in shade, brilliancy, fastness to light or to washing, dyeing properties and so forth—or else have been brought out and pushed in competition with the former ones, by one or the other of the great manufacturers of dyes. The quality of the dyes therefore has been steadily improving, year by year. New and simpler methods of applying them have been discovered; they have been made more cheaply, and in the form of Diamond Dyes, Easy Dyes and the like have been brought within the reach of any one, even in comparatively scattered communities, who wishes to make use of them. Then too, the art of mixing and blending the shades so as to make soft, harmonious tints out of the hardest, fiercest, most brilliant colors has at last been generally learnt. So that it would be hard, now, to think of a civilized world without the beauty of color due to the coal-tar dyes.

It would seem enough, for any one man, to witness, during his active career, the development of a great new industry like this manufacture of dyestuffs, resulting directly from his own youthful efforts. But the extraordinary thing about Perkin's life is that this industry, great as it is, proved to be but a stepping-stone to results which could never have been imagined at the beginning, but which, long before he died, had affected the very life of practically the whole world. Some of these I hope to describe in a later paper.

Charles E. Pellew